Science Learning at the Zoo: Evaluating Children's Developing Understanding of Animals and their Habitats

BRADY WAGONER
Aalborg University

ERIC JENSEN
University of Warwick

Abstract

Zoos attract hundreds of millions of visitors every year worldwide – many of them children. In the UK, hundreds of thousands of school children visit zoos every year. Thus, the zoo is a key institution for publics engaging with live animals and environmental education. However, zoos have recently come under ethical criticism linked to the claim that they have negligible or even negative educational impact. While there is some evidence of positive outcomes for adult zoo visitors, there is very little prior research available to answer such criticisms when it comes to children. To address these issues, a study was conducted using a mixed methods survey, which included a key visual component designed to track changes in children's representations of animals over the course of a school visit to the zoo. Specifically, the study investigated the development of new ideas about animals, habitats and the zoo amongst a sample of pupils attending ZSL London Zoo. Results indicate the potential of educational presentations based around zoo visits, for enabling conceptual transformations relating to environmental science. At the same time, the research highlights the vital role of existing cultural representations of different animals and habitats which are confronted by the new ideas introduced during educational visits to the zoo.

Zoos attract hundreds of millions of visitors every year worldwide (World Association of Zoos and Aquariums, 2009). In the UK, hundreds of thousands of school children visit zoos every year. As such, zoos represent one of the primary points of engagement between live animals, biological science and publics of all ages. Some argue that zoos have a major impact on public perceptions of animals, for better or for worse (e.g. Berger, 2009). Yet, zoo critics contend they have negligible or even negative educational impact (e.g. Jamieson, 2006). Such negative assessments of zoos' ability to educate publics are often tied to bioethical criticism of zoos as institutions that hold animals in captivity (e.g. Captive Animals Protection Society, 2010). Identifying evidence of educational impact is crucial to contemporary zoos seeking justify their role as charities delivering environmental education and promoting animal conservation. At the same time, rising concern about the need for publics to be engaged with the sciences (e.g. Holliman et al., 2009; Holliman & Jensen, 2009; House of Lords Select Committee on Science and Technology, 2000; Jensen & Wagoner, 2009) offers zoos opportunities to position themselves as a key forum for science engagement and conservation education.

However, prior research on zoos often eschews fundamental questions about zoos' ability to deliver public science education, instead focusing on specific practical variables, such as viewing area size (e.g. Moss, Francis, & Esson, 2008) and the relative credibility of different zoo-based personnel (e.g. Fraser et al., 2008). Moreover, amongst previous published studies of

zoo impacts, most use post-visit only or aggregate data (or both), thereby making it impossible to identify patterns of conceptual development that are valid at the level of the individual (Molenaar, 2004). Indeed, a range of methodological shortcomings further undermine the conclusions (both positive and negative) of most such studies of zoo-based environmental education.

Beyond methodological limitations, Fraser (2009) has identified a paucity of evaluation research focused on children visiting zoos. Indeed, published studies of zoo impacts routinely exclude children from the samples. For example, Fraser (2009) recently conducted a study of parents' perspectives on the value of zoo visits. Interviews and observations of zoo visits were undertaken with eight families (14 adults). The study concluded that "parents conceive of the zoo as a useful tool [...] to promote an altruistic sense of self, and to transfer their environmental values. [...] They could use these visits to actively support their children's self-directed learning" (Fraser, 2009, p. 357). However, the study only discusses parents' assumptions of the impact of zoos on their children- or what Fraser calls '*anticipated* utility'. The *actual* utility of visiting the zoo for these children was not investigated, leaving this issue open to further study.

This manuscript reports on a study designed to pilot an innovative approach to establishing robust idiographic evidence of zoo-based environmental education's impact children's thinking about animals and habitats, which overcomes some of the limitations of prior research. The present case focuses on London primary school pupils' development of new knowledge through participation in London Zoo Formal Learning activities. In particular, this study investigated the impact of an educational activity aimed at promoting pupils' comprehension of specific animals and their habitats under the title 'Desert & Rainforest'. This activity is described on the ZSL website as follows:

> Why do monkeys balance on branches, or meerkats burrow in the desert? These sessions help children think about answers to these questions and to understand animal adaptations to habitats.[1]

This presentation is delivered by a London Zoo education officer in a room inside the 'Clore Rainforest' building within the zoo- with pupils seeing other parts of the zoo before and after the presentation. The pilot study results provide preliminary evidence of the impact of such zoo-based educational activities.

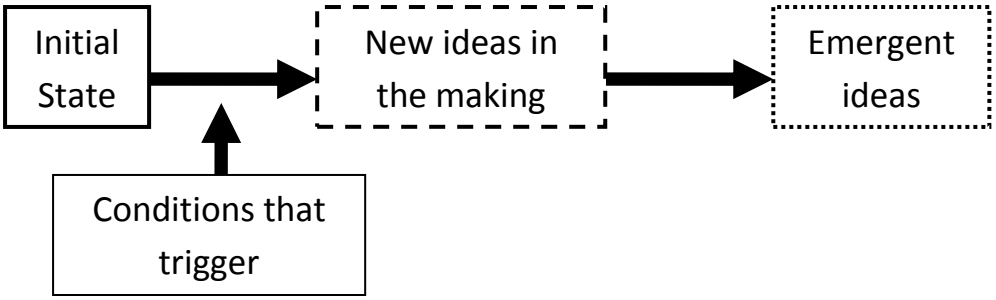
METHODS

The present study sought to capture qualitative changes in children's thinking as a result of their participation in the ZSL London Zoo's formal learning programmes. As such, we adopted a method that focuses on single cases and their development over time in order to explore the emergence of novel ideas. As opposed to simple aggregate statistics, this approach provides a *dynamic display of change processes* (e.g., see Wagoner, 2008). Figure 1 schematically outlines the framework of conceptual change behind this methodological approach: from an initial

[1] This quote is from http://www.zsl.org/education/schools/zsl-london-zoo-schools/primary-programme-at-zsl-london-zoo,189,AR.html (Last accessed 15 April 2009).

psychological state, certain conditions (e.g. an educational presentation at the zoo) trigger a constructive process (e.g. thinking about "habitats") which results in the emergence of new ideas (e.g. a new concept of animal habitats). This kind of detailed evaluation is necessarily small in terms of the sample size, but it involves close examination of the developmental trajectory of individual pupils during zoo visits and associated learning activities.

Figure 1 – Schematic Diagram of Research Focus (modified from Valsiner, 2000, p78)



In the present study the aim is to track changes in pupils' thinking that could be attributed to the London Zoo Formal Learning programme's educational presentations. From a day of ethnographic observation undertaken prior to conducting the pilot microgenetic evaluation we learned that a key emphasis in Formal Learning sessions for primary school pupils was animal adaptation and "habitats". Our methods were thus tailored to explore this domain of pupils' thinking. To elicit pupils' understandings of habitats we had children draw different animals that were discussed in the 'Desert & Rainforest' Formal Learning session "where they live in the wild" both before and after the presentation. A drawing task, such as this, provides children with a way to concretely explore an abstract concept such as "habitat".

Each pupil was asked to draw a picture of either a Meerkat and Sloth, or a Camel and Jaguar, in their habitat. These two versions of the questionnaire were employed to control for differences in children's affinity and therefore learning related to any one particular animal. We chose to focus on these animals because (1) their habitats are deserts and rainforests (respectively), (2) they feature in the educational talk, and (3) the pupils can also see them live at the London Zoo—thus, we would also have the option of observing pupils interacting with the animals after the educational talk.

Primary School pupils age 9 – 11 from two schools were recruited for the study on 2 April 2009. Twenty-seven pupils from one London state primary school and 55 from another received the *meerkat and sloth* questionnaire, while the remaining 28 from a third state primary school received the *camel and jaguar* questionnaire.

Questionnaires were administered both before and after the educational presentation. The purpose of these questionnaires and their timings was to capture any changes in pupils' thinking about animals and their habitats as they participated in different zoo activities. The pre- and post- educational presentation questionnaires were intended to measure the impact of the talk on pupils' developing understanding of habitats and zoos.

RESULTS

There was a noticeable change towards greater understanding of animals and habitat in pupils' drawings in about a third of our sample. This does not mean that knowledge change did not occur in the other pupils; it simply means that our methodology has not captured it. At the end of the present report we will describe how our methodology will be refined to access more changes in children's thinking in later phases of this research. Below, we focus on the analysis of illustrative cases displaying changes in drawings of meerkats, sloths, camels and jaguars. This analysis enables us to see holistic qualitative changes in drawings, while at the same time commenting on general trends within the sample.

Meerkat drawings

Scientific content communicated during the 'Desert & Rainforest' educational session showed up most clearly in the pupils' drawings of meerkats. In Figure 2, the pupil first drew a meerkat surrounded by dense trees and bushes, and explained her drawing as "a meerkat in a not dry place" (emphasis added). Indeed, many pupils in our sample put meerkats in the "rainforest" in their pre-presentation drawings and changed to place them in a "desert" in their post-presentation drawing. In this pupil's post-presentation drawing, the meerkat is placed amongst flat planes and pyramids, that is, "in a desert" as she explains. Unexpectedly, pyramids showed up in many pupils drawings of a desert. We can infer that their image of deserts is derived from stereotyped media images of, for example, Egypt.

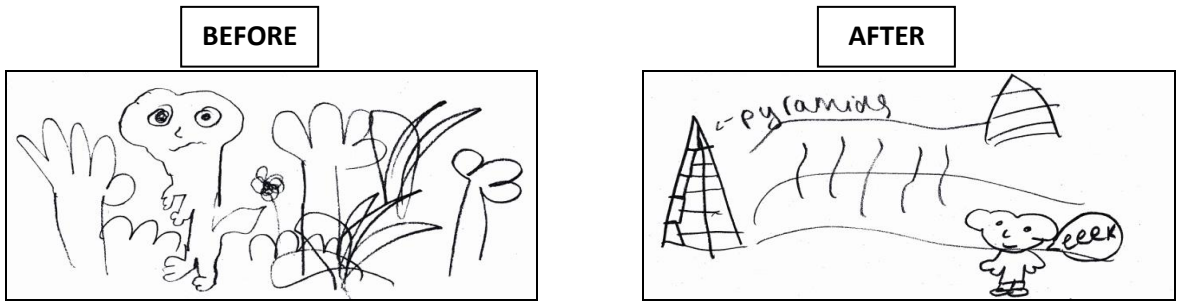


Figure 2 – Drawing of a meerkat in its habitat pre-presentation (left) and post-presentation (right) by female 10 years.

This same pupil also drew a speech bubble with the letters "eeek" next to the meerkat. In the educational talk, the education officer explained that meerkats made three noises to communicate different situations: "eeeeeik," "eik" and "grrrr". These sounds were included using talk bubbles in many pupils' drawings. After the talk we observed this class at the meerkat exhibit and found about a third of them making these noises in an attempt to get the meerkat's attention! When asked what the sounds "meant" to the meerkat, the children could accurately explain without hesitation. This finding suggests the importance of including authentic sounds, regarding the animals under discussion, in order to connect with some

children's preferred learning styles and interests. The drawing on the right (below) has the meerkat making an 'eek' sound.

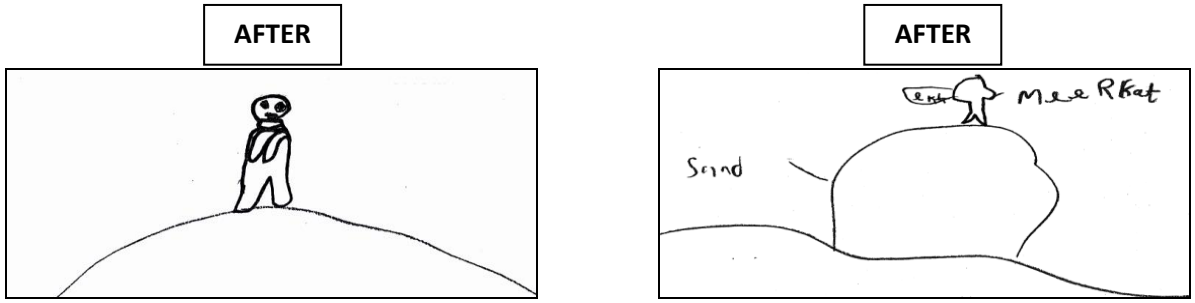


Figure 3 – "A meerkat being on guard" (left) and "a meerkat warning his family" (right). Both are post-presentation drawings by males 10 years.

Another common theme found in pupils' drawings (above) was meerkats on a hill or rock standing on their hind legs. This is a meerkat behaviour that many pupils seemed to know about before entering the zoo, though there is a greater number in post-talk drawings (probably as a result of a slide in the educational talk of a meerkat on top of a rock watching for danger). However, prior to the education talk children did not seem to have an explanation for this meerkat behaviour. The presentation provided this scientific explanation. For example, one pupil drew almost identical pictures of a meerkat for the pre- and post- talk questionnaire (Figure above, left) but crucially the pupil's description changes. In the pre-talk questionnaire he writes, "I drew a meerkat <u>standing</u> on a rock" (emphasis added). Post-talk, this becomes, "I drew a meerkat <u>being on guard</u>" (emphasis added). The first is merely a physical description of the behaviour, while the second goes deeper to provide a scientific explanation. Another pupil (above) drew a picture of a meerkat saying "eek" from on top of a big rock in the post-talk questionnaire (in his pre-talk drawings the meerkat is in a flat sandy landscape). This pupil explains his drawing as "a meerkat warning its family" (Figure above, right). A third pupil also added a scientific description to this meerkat posture in his post-presentation drawing, as "look out for predators". The predators themselves (e.g. Eagles) only showed up in two of the pupils' drawings (see Figure below).

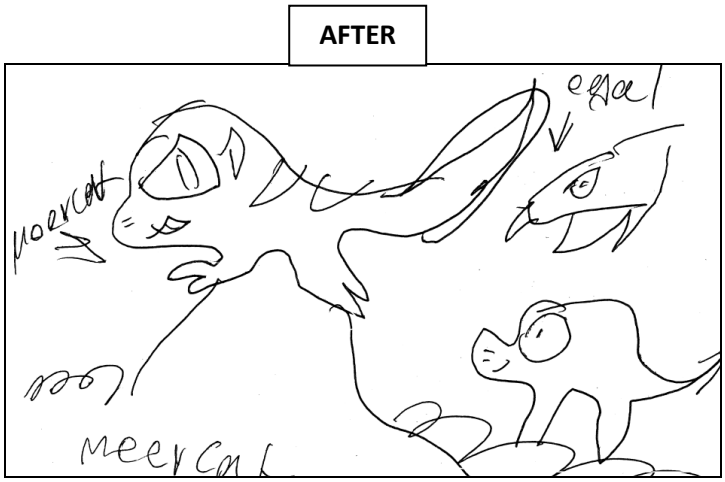


Figure 4 – Post-talk drawing of meerkats and eagle by male 11 years.

The limited inclusion of predators in the drawings is likely a result of both the less extensive coverage of these predators in the talk and the fact that the questionnaire instructions did not explicitly call for this kind of detail.

Sloth drawings

Most of the pupils from third primary school saw the sloth just before going into the educational talk and thus drew an animal "hanging" on a tree in their first drawing of the sloth. However, new symbolic elements were still added by many pupils in the second (post-presentation) drawing. For example, in the drawings displayed below the pupil's post-presentation drawing adds details including the sloth's claw-like fingers and a talk bubble with the words "I'm not going down" in it. Both these features of the sloth were themes brought up in the educational session.

Figure 5 – Drawing of a sloth in its habitat pre-presentation (left) and post-presentation (right) by same pupil as in Figure 2. Female 10 years.

This pupil also placed the sloth "in a dry place" in her pre-presentation drawing, which changes to "in a rainforest" post-presentation. The only kind of drawing that was different from this in this school was a picture of a sloth on the ground with a "poo" next to it – in the talk it was discussed that the sloth comes down from the tree only once a week in order to defecate.

The second school's pupils did not see the sloth before the education talk and as a result had only vague knowledge of the animal. Most of the children simply left the drawing space for the sloth blank in the first questionnaire or wrote "don't know," "not sure" or "?". Interestingly,

however, a number of pupils drew a picture (in the pre-talk questionnaire) of an amorphous animal next to an igloo (see Figure 6, below) and/or wrote "a cold habitat" or "ice".

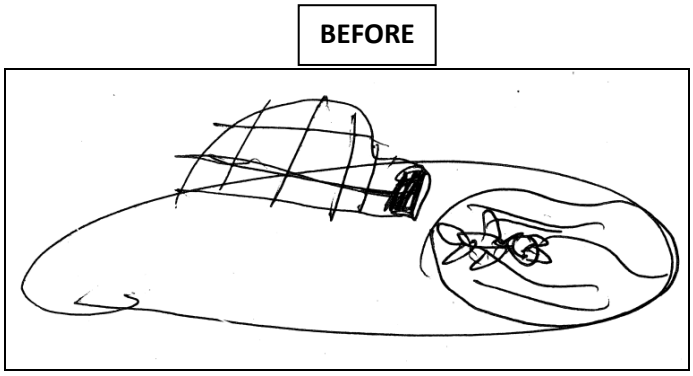


Figure 6 – Pre-presentation drawing of a sloth and an igloo by male 10 years.

One pupil elaborated in his pre-presentation questionnaire, "saw it [a sloth] on the film Ice Age → next to caves, woods". The landscape of the film is filled with snow and ice as the movie poster (see Figure below) indicates. Many pupils from this second school seemed to be operating under a "hot" and "cold" distinction when discussing animal habitats – the sloth belonging in the cold. This may be due in part to the influence of films such as Ice Age.

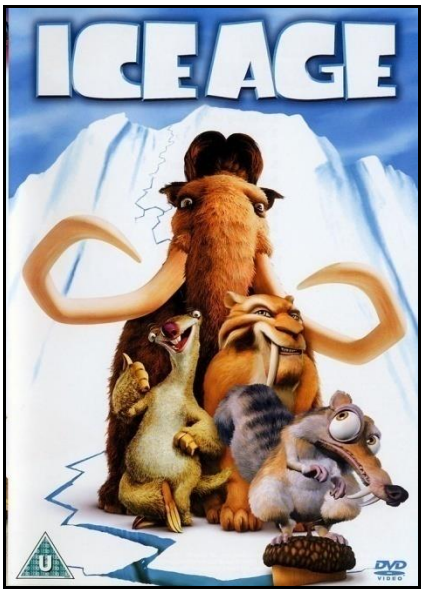


Figure 7 – Ice Age movie poster (last accessed at http://www.reel.com on10/04/09). Sloth pictured on the left, foreground.

Without other information, these pupils were utilizing Hollywood movies as symbolic resources to contextualise their understanding of the sloth and its habitat. In other words, they filled in the gaps in their knowledge with whatever resources were available to them. This finding points to the role of mass media in structuring pupils' knowledge and attitudes towards

animals and their habitats. Nevertheless, after the educational talk all but one of these pupils located the sloth in the rainforest, and in most as hanging upside down from a tree as in Figure above.

Camel drawings

A separate questionnaire with camels and jaguars (rather than meerkats and sloths) was delivered to about half of the sample in order to examine any differences in knowledge formation on the basis of which animals pupils were asked to draw. On this form, pupils generally drew a camel with two humps surrounded by sand in both their pre- and post-presentation drawings, though there was a greater frequency of one humped camels post-presentation (one humped camels were shown in the educational talk; whereas two humped camels must be the more stereotypical cultural representation). Since the pupils already evinced this basic level of knowledge, the camel drawings were less helpful overall in chronicling the changes in pupils' knowledge of animals in their habitats. However, we can still point to some interesting and illustrative examples of pupils developing beyond this basic level of knowledge. Consider the following pre- and post- talk drawings in Figure below, which show a significant increase in knowledge and sophistication:

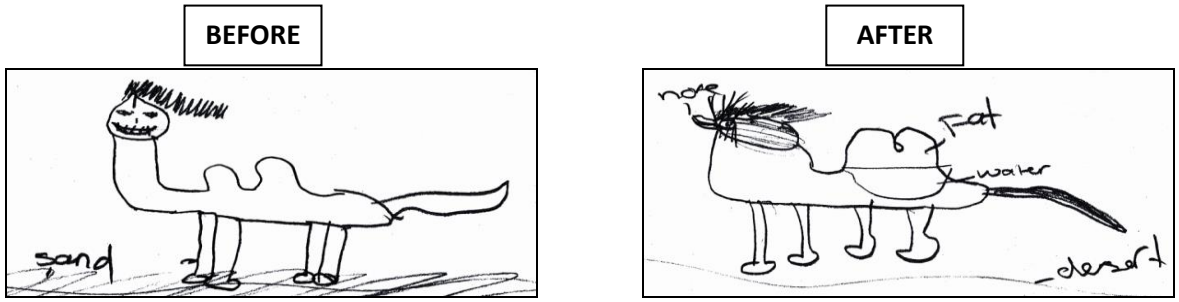


Figure 8 – Drawing of a camel in its habitat pre-presentation (left) and post-presentation (right) by male, age 10.

Indeed, multiple themes discussed in the educational presentation appeared in this pupil's post-talk drawing (Figure, above). For example, it is shown that the camel stores large quantities of water in its stomach and fat in its humps. Also, the camel is given long eye-lashes and a long nose. In the presentation, all of these features were highlighted as adaptations to desert conditions. This example shows that some pupils elaborated their understanding of camel physiology as a result of the presentation, even within the context of widely held cultural stereotypes regarding two-humped camels.

Jaguar Drawings

A more limited range of knowledge transformations was visible in jaguar drawings. The only significant change post-talk was that many pupils added spots to the Jaguar, if their drawings did not already include spots in the first instance. The Figure below is a particularly clear example of this pattern.

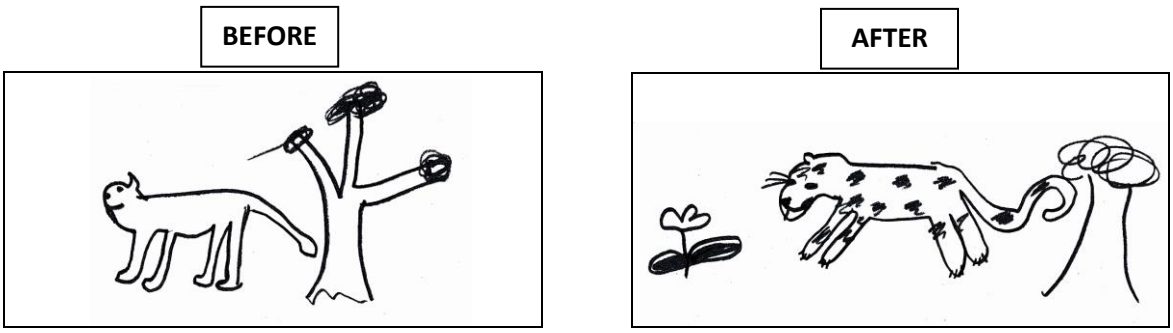


Figure 9 – Drawing of jaguar in its habitat pre-presentation (left) and post-presentation (right) by female, age 10.

Though this pupil does not elaborate the surrounding habitat in either of her drawings, she writes 'a jaguar in South Africa' under her first drawing and 'a jaguar in the rainforest' under her second. From this we can infer that before the talk there is little differentiation in her representation of 'big cats'—that is, lions and jaguars. Without other information she draws on her existing knowledge of lions' habitat to situate the jaguar. This also helps to explain why she did not include the jaguar's spots in her pre-talk drawing even though spots can be seen in the image of a jaguar's face included on the questionnaire. In this case, the pupil's cultural framework for understanding big cats is a more powerful guide to her pre-talk representation than the jaguar image provided. After the talk this is clearly no longer the case—the jaguar is now understood as a rainforest animal with spots.

DISCUSSION

The innovative evaluation method employed in this study yielded findings regarding the kinds of knowledge development fostered amongst children visiting the zoo as part of the London Zoo Formal Learning programme. Indeed, it is clear from the primary school pupils' drawings that they have developed new knowledge and refined existing knowledge about animals in their habitats as a result of participating in London Zoo educational activities. Pupils were even observed trying to use their new knowledge to elicit particular behaviour in live meerkats, by making noises such as "eik" and "grrr", when they came into contact with them in the Zoo after the educational session. Moreover, pupils had clearly understood that these calls were adaptive mechanisms used by meerkat communities to respond to the dangers in their environment. After the educational session, most pupils easily placed the animals in their respective habitats, despite some difficulties in doing so beforehand.

Overall, this preliminary study shows significant impact on the quantity and quality of pupils' knowledge about animals in their habitats as a result of the 'Desert & Rainforest' educational session. In addition, this study highlights the crucial role of variables outside of the direct context and motivations surrounding the zoo visit itself. The cultivation of pre-visit representations of animals, habitats and the environment occurs over an extended period of time through the influence multiple sources, including formal education and mass media.

Education within the zoo must interact with such pre-existing ideas in the process of visitors' development of a new understanding of animals and their environments.

Directions for Future Research

In addition to the substantive goals of measuring change in pupils' knowledge, this study also had the methodological aim of informing future iterations of evaluation research at London Zoo. We have identified a number of interesting directions for future research, building on the successes and lessons learned in this initial study. For example, one additional step we may employ in future research could be to test primary school pupils' adeptness at placing animals *not* covered in the talk in either a desert or rainforest habitat to check whether the development of their understanding about the relationship between animals and habitats generalized beyond the animals discussed during the educational presentation. To do this we could provide a detailed picture of another animal and ask where they would expect to find it and why.

Another methodological development could be to encourage primary school pupils to elaborate their drawings of habitats as much as possible, including other animals and plants found there, so as to access the pupils' total understanding of the animal's environment, rather than the most salient aspects. After conducting several days of data collection we better understand the practical constraints on questionnaire completion. Thus, in the future we would have each pupil draw only one animal in its habitat but do so in more depth. Additionally, we will add an instruction that they should incorporate as much new knowledge, learned at the talk or from seeing the animals in the zoo, as they can.

Finally, primary school pupils utilized a number of cultural resources to understand animals in their habitats – for example, Hollywood movies (i.e. *Ice Age*) and conventional images of the desert (i.e. with the pyramids in the background. Information provided by these resources was sometimes replaced by other information – i.e. from the educational presentation – while other times the two co-existed (e.g. pyramids continued to show up in post-talk drawings of deserts). Given the important role of media representations in public understanding of science (e.g. see Jensen, 2009a; Jensen, 2009b), it could be very fruitful to further explore pupils' use of media resources (e.g. Disney films) to understand animal habitat before visiting the Zoo and the way in which they integrate this media knowledge with learning during their visit. Furthermore, we do not know the extent to which new knowledge is retained in the long term. It may be that the durability of knowledge developed at the zoo will depend on how it fits or contrasts with such pre-existing information. In future iterations of this research, we are intending to distribute follow-up questionnaires at set intervals (e.g. six months, one year, etc.) to explore such issues longitudinally. Additionally, a study of classroom activities focused on the zoo visit would ground our understanding of pupils' knowledge development. Methodologically speaking, we would identify what concepts, phrases and ideas recur in the classroom and in pupils' reports, and how their knowledge is reorganized to meet the demands of these different contexts.

To conclude, further large-scale research is needed to assess the generalizability of the present evaluation research results for the larger population of children visiting contemporary zoos. We are currently analyzing data from just such a large-scale study of children and young people engaged by the ZSL London Zoo Formal Learning programme using methods similar to

the present study. This ongoing research uses the general approach developed for this study with the explicit aim of using further, longer-term follow-up questionnaires to evaluate zoo-based environmental education's impact longitudinally.

REFERENCES

Berger, J. (2009). *Why look at animals?* London: Penguin.

Captive Animals Protection Society. (2010). Sad eyes and empty lives: The reality of zoos. Retrieved 21 January, 2010, from http://www.captiveanimals.org/zoos/factsheet.htm

Fraser, J. (2009). The anticipated utility of zoos for developing moral concern in children. *Curator: the Museum Journal, 52*(4).

Fraser, J., Taylor, A., Johnson, E., & Sickler, J. (2008). The relative credibility of zoo-affiliated spokespeople for delivering conservation messages. *Curator: the Museum Journal, 51*(4), 407-418.

Holliman, R., Colllins, T., Jensen, E., & Taylor, P. (2009). *ISOTOPE: Informing Science Outreach and Public Engagement. Final Report of the NESTA-funded project*. Milton Keynes: The Open University.

Holliman, R., & Jensen, E. (2009). (In)authentic science and (im)partial publics: (Re)constructing the science outreach and public engagement agenda. In R. Holliman, E. Whitelegg, E. Scanlon, S. Smidt & J. Thomas (Eds.), *Investigating science communication in the information age: Implications for public engagement and popular media* (pp. 35-52). Oxford: Oxford University Press.

House of Lords Select Committee on Science and Technology. (2000). *Third Report on Science and Society*. London.

Jamieson, D. (2006). Against zoos. In P. Singer (Ed.), *In defence of animals* (pp. 132-143). Oxford: Blackwell.

Jensen, E. (2009a). Genetic futures and the media. In *The Encyclopaedia of Life Sciences*. Chichester: John Wiley Publishing.

Jensen, E. (2009b). Review: Human cloning in the Media. *Public Understanding of Science, 18*, 373-374.

Jensen, E., & Wagoner, B. (2009). A cyclical model of social change. *Culture & Psychology, 15*(2), 217-228.

Molenaar, P. (2004). A manifesto on psychology as idiographic science: Bringing the person back Into scientific psychology, this time forever. *Measurement, 2*(4), 201-218.

Moss, A., Francis, D., & Esson, M. (2008). The relationship between viewing area size and visitor behavior in an immersive Asian elephant exhibit. *Visitor Studies, 11*(1), 26-40.

Wagoner, B. (2008). Developing 'development' in theory and method. In E. Abbey & R. Diriwatcher (Eds.), *Innovating genesis: Microgenesis and the constructive mind in action* (pp. 39-61). Charlotte, North Carolina: Information Age Publishers.

World Association of Zoos and Aquariums. (2009). Zoos & Aquariums of the World. Retrieved 28 December, 2009, from http://www.waza.org/en/site/zoos-aquariums